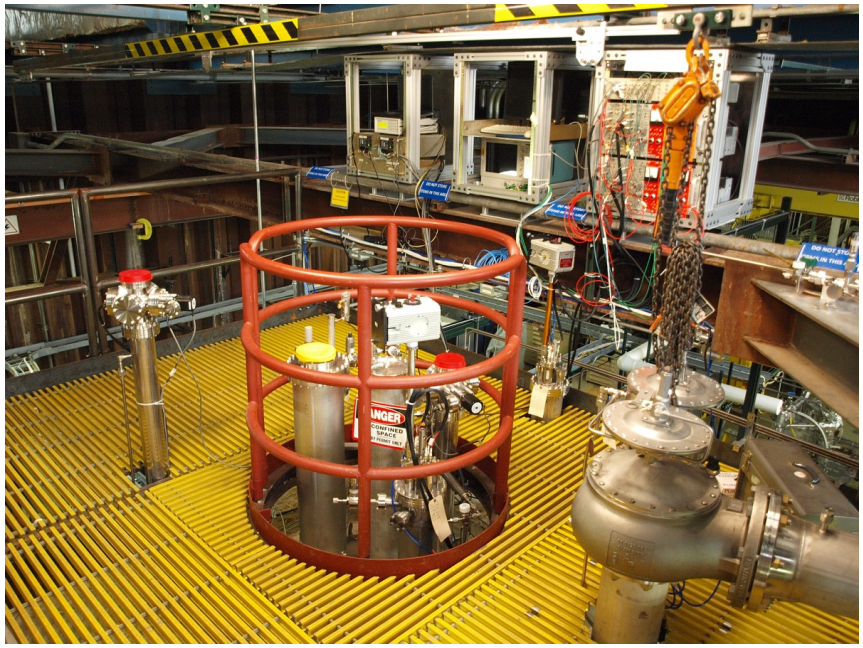
Electron Lifetime Measurements at the LAPD



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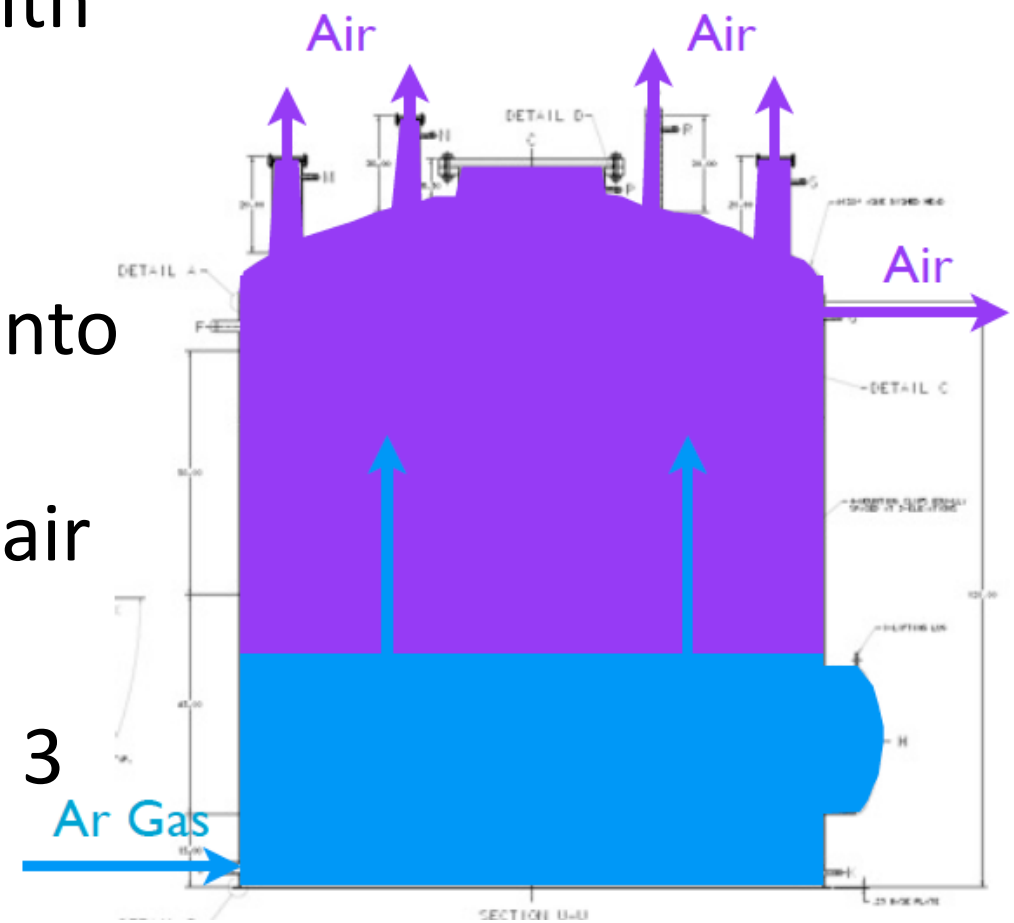
Why LAPD?

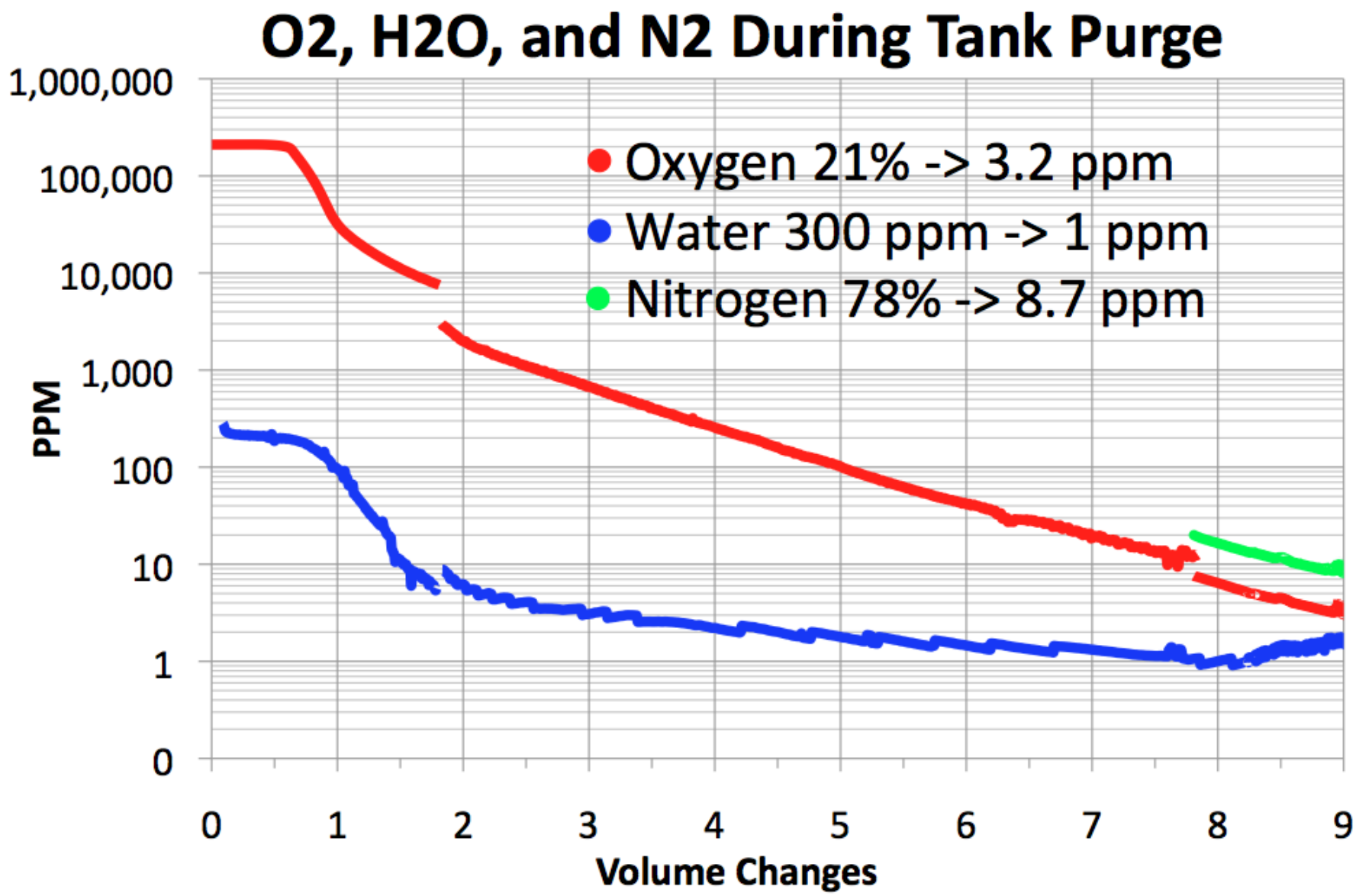
- Currently operating systems such as the Material Test Stand at FNAL and ArgoNeuT use evacuation as the 1st step to achieve the high purity that liquid argon TPCs require
- Contaminants are electronegative impurities such as Oxygen and Water
- Building large vessels that can be evacuated is expensive - scales the cost by at least a factor of 2 for small vessels, more for large vessels
- Want an alternative to evacuation for large vessels - LAPD is test stand at FNAL to study possibility of filling with liquid argon without prior evacuation
- Need to show an electron lifetime of 3 ms for a 2.5 m drift distance

1st Step – Argon "Piston" Purge

- Tank started filled with air at ambient temperature
- Argon gas was sent into the tank bottom to push the less dense air out the top.
- Flow rate was about 3 hours per volume change.



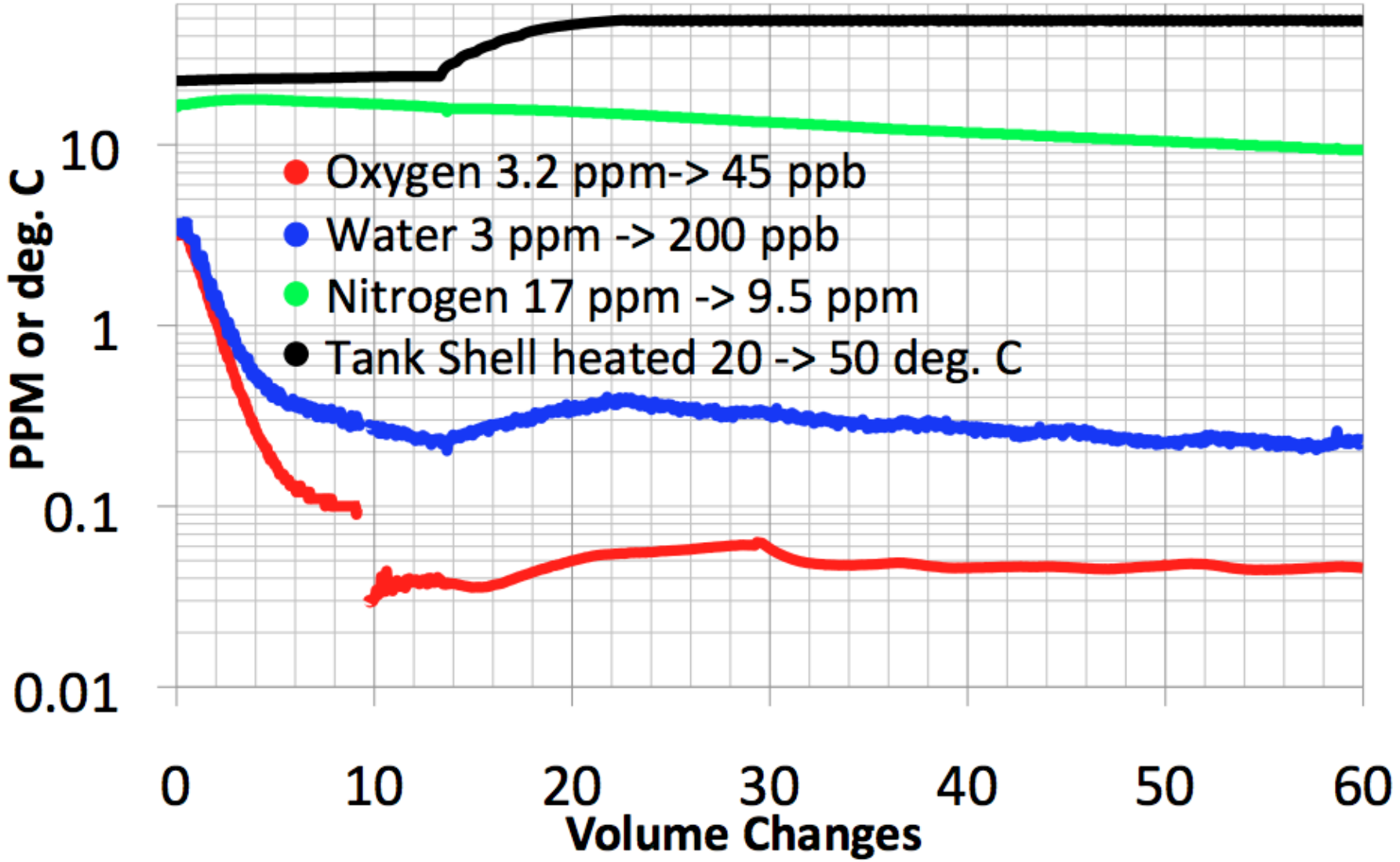
Tank size: 6,508 gal (25,000 liters)
30 tons LAr


O2, H2O, and N2 During Tank Purge
1,000,000
100,000
10,000
1,000
100
10
1
0
PPM
Oxygen 21% -> 3.2 ppm
Water 300 ppm -> 1 ppm
Nitrogen 78% -> 8.7 ppm
0
1
2
3
4
5
6
7
8
9
Volume Changes

2nd Step – Gas Recirculation

- A bellows pump moved gas from the tank thru the mole sieve and oxygen filters at a rate of a volume change every 3.2 hours.
- Tank shell heated to 50 deg. C to drive off H2O
- A mole sieve filter regeneration mistake raised the tank N2 from 8.7 ppm to 17 ppm.
- After 60 volume changes measured O2 and H2O levels stopped decreasing
- Gas recirculation continued for an additional 100 volume changes while the liquid fill logistics were worked thru

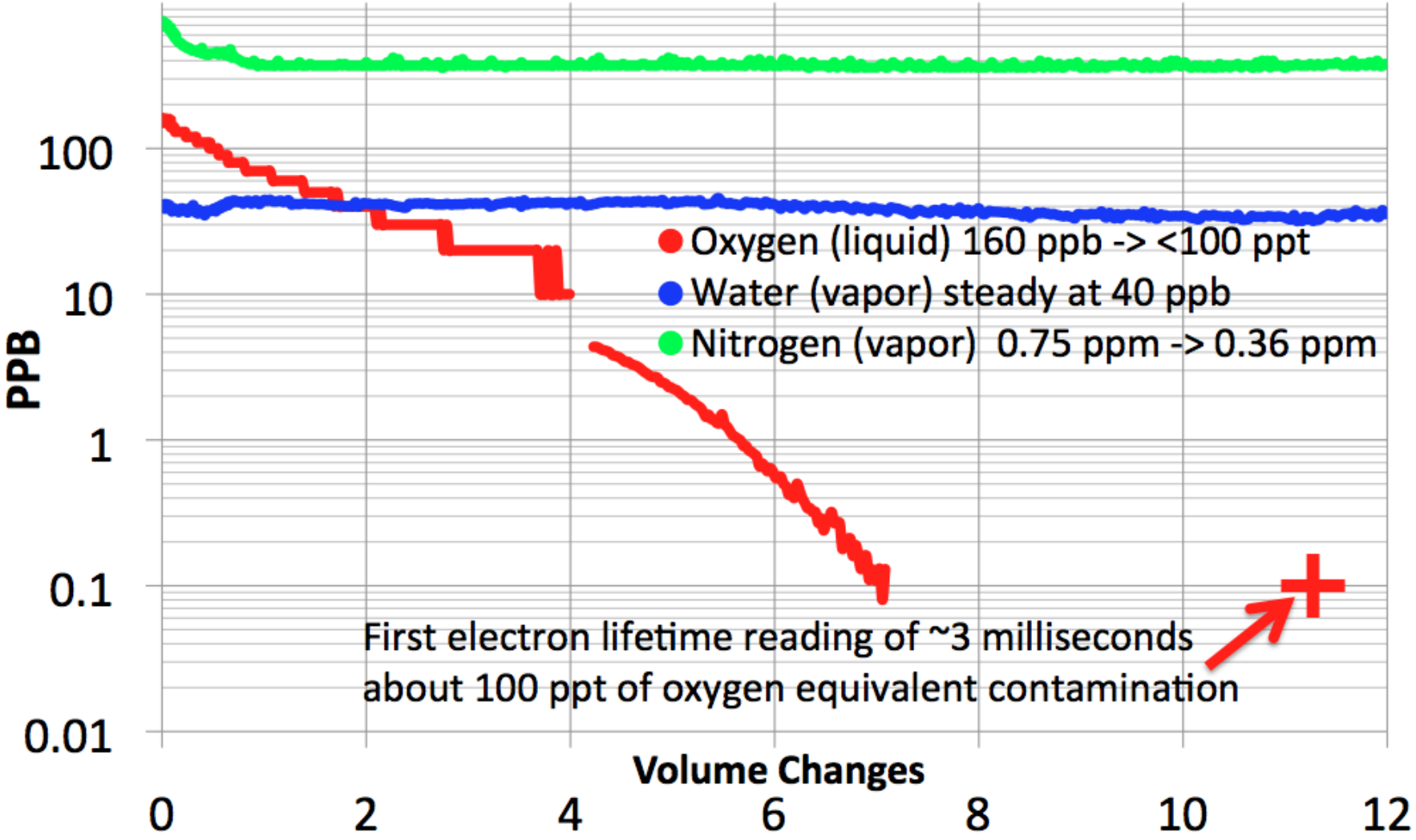
O2, H2O, and N2 Tank Gas Recirculation

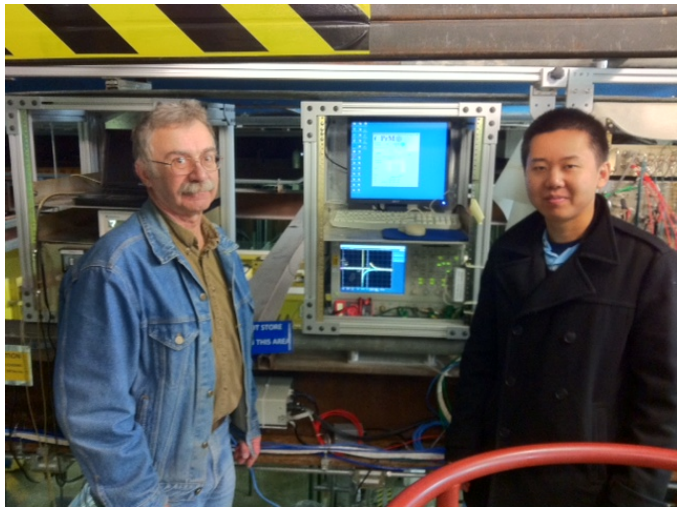


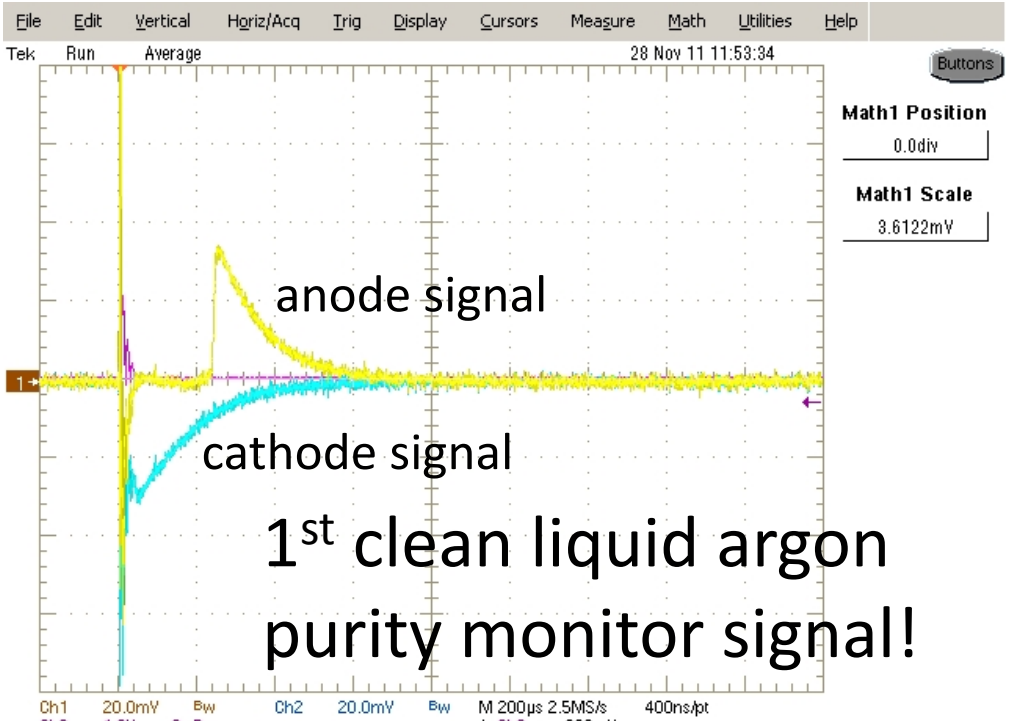
Liquid Fill and Liquid Recirculation

- Tank filled with 0.22 ppm O2 and 0.3 PPM N2 LAr – only partially filtered during fill due to filter issues
- Tank is only 35% full which is a tougher test with respect to purity – upper portions of tank shell are warm and actively outgassing H2O
- Liquid pump moved argon thru filters at rate of 5.5 hrs/vol change.

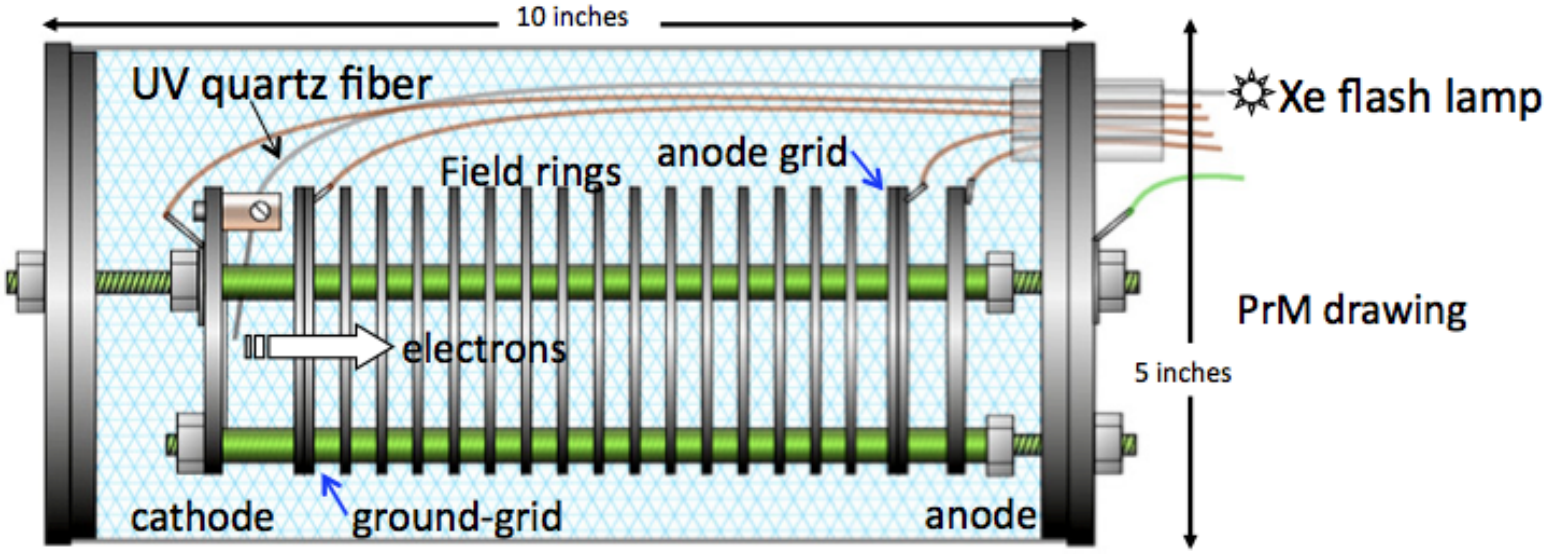
O2, H2O, and N2 During Liquid Recirculation







1st clean liquid argon purity monitor signal!



Conclusions and Future Work

- LAPD has shown that it is possible to obtain the electron lifetime required by LArTPCs in a sizeable vessel without evacuation
- Near term work
  - Improving purity monitor noise so that very long electron lifetimes can be measured
  - Add additional liquid argon to fill the tank completely and submerge the two of the 4 purity monitors that are currently in vapor
  - Doubling the liquid filtration speed
  - Turning on the vapor filtration
- Installation of a small cylindrical TPC to demonstrate a 2+ meter electron drift